Evaluation of plastic and Mylar flagging as repellents for snow geese (*Chen caerulescens*)

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The effectiveness of white flags, black flags and Mylar streamers as visual repellents to snow geese (*Chen caerulescens*) was evaluated. Five farms in Cumberland and Salem counties, New Jersey served as test sites. At each farm, four 10.12 ha fields were selected randomly, and then assigned to four treatment conditions: (a) white plastic flags (one flag per 0.4 ha); (b) black plastic flags (one flag per 0.4 ha), (c) Mylar streamers (one streamer per 0.4 ha); and (d) stakes only (one stake per 0.4 ha). From 2 December 1992 to 24 March 1993, vegetation samples and goose droppings were collected in all fields. Dropping weights were significantly less in black- or white-flagged fields than they were in fields with Mylar streamers or bare stakes. Although vegetation weights tended to increase in white- or black-flagged fields (and to decrease in fields with Mylar streamers or bare stakes), there were no significant differences. The results show that white or black flags can economically and effectively deter snow geese from agricultural fields, at least when alternative grazing sites are available.

Keywords: goose; flagging; repellent

Populations of greater snow geese (*Chen caerulescens atlantica*) and reports of crop depredation by these birds are increasing throughout the eastern United States (Anonymous, 1981; Gauthier and Bedard, 1991). Although damage can occur throughout the winter, it is most severe in late February and early March when the birds engage in premigratory fattening (Ankney, 1977). In New Jersey, rye, clover, winter wheat and grass turf are damaged, and farmers complain that overgrazing reduces crop yields (Bedard, Nadeau and Gauthier, 1986; Summers, 1990; McKay *et al.*, 1993). Damage also compromises nitrogen fixation by rye and clover, and the ability of these cover crops to prevent wind erosion of the soil (Mason, Clark and Bean, 1993). Because geese are a vector for the transmission of agriculturally important pathogens and parasites (Mason *et al.*, 1993), even farmers without substantial goose damage to crops worry about visits by flocks to their fields.

Chemical repellents such as methyl anthranilate may become available for goose damage control (Cummings *et al.*, 1991), but no substance currently is registered with the U.S. Environmental Protection Agency as a goose grazing deterrent. Existing legal control strategies include hunting and harassment, planting unattractive cover crops and lure crops (Owen, 1978, 1990; Gauthier and Bedard, 1991), and the use of auditory repellents (Conover and Chasko, 1985). None of these strategies is entirely effective, and additional methods are being sought. One such method may be the use of flags and streamers (Knittle and Porter, 1988; Heinrich and Craven, 1990).

During February and March of 1992, we evaluated the effectiveness of white flagging as a deterrent to snow goose grazing (Mason *et al.*, 1993). During the 6-week trial period, grazing damage in flagged fields was significantly less than it was in control fields. This result is consistent with reports concerning the effectiveness of black flags and silver/red Mylar streamer tapes as waterfowl grazing deterrents (Knittle and Porter, 1988; Heinrich and Craven, 1990; Summers and Hillman, 1990).

The present experiment was conducted to evaluate whether white flags were more effective than black flags or Mylar streamers as visual deterrents to snow geese. We suspected that differences might exist, since avoidance of colours (and, by extension, flag types) may be species typical, there is no experimental evidence to support the use of black flagging, and Mylar streamer tape has been evaluated only against Canada geese (*Branta canadensis*).

Materials and methods

Study sites

Five farms were selected in Cumberland and Salem counties, New Jersey. On each farm, four 10.12 ha fields, spaced at least 0.75 km apart, were selected randomly. This field size is common for New Jersey, a state where the average farm size is 40.06 ha (Bureau of Census, 1987). Selection was based on a variety of agronomic factors including similarities of planting date, crop type, and barriers to the wind. Rye (*Secale cereale*) was planted in 16 fields, grass (*Phleum* sp.) in two fields, and clover (*Trifolium* sp.) in two fields.

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Landowner reports and our own observations between 1985 and 1992 indicated that all 20 fields consistently experienced grazing damage by snow geese.

Procedure

On each of the five farms, the four fields were randomly assigned to four treatment conditions (white flags, black flags, Mylar streamers, or control stakes). These treatments were implemented on 24 and 25 November 1992. For each field that received white or black flags, 25 rectangular flags were prepared by stapling plastic garbage bags (77 × 154 cm) width-wise onto 1.2 m lengths of pine lathe. These flags were positioned in the ten fields in these two treatment conditions (n = five fields per condition). In all cases, one flag was positioned in the centre of each acre (2.47 flags ha^{-1}, 25 flags per field) to create a grid in accordance with: (a) published recommendations for the use of flagging as waterfowl deterrents (2.47 flags ha^{-1}; Timm, 1983); and (b) procedures followed during our previous evaluation of white plastic flags as snow goose deterrents (2.47 flags ha^{-1}; Mason et al., 1993). The top edge of each flag was ~0.9 m above the ground.

For fields that received Mylar streamers, 0.9 m lengths of 10 cm wide red/silver Mylar tape were stapled width-wise to 1.2 m lengths of pine lathe. The streamers were positioned in the five fields in this treatment condition as described above. For the five fields in the control treatment, 1.2 m lengths of pine lathe were positioned as described for flags and streamers.

Within each of the 20 fields, four transects were established between a randomly selected pair of adjacent lathe stakes. The endpoints of each transect were marked by spraying the lathe with black paint. The length of each transect was measured using a Measure-master wheel (model no. MM30, Rolatape Corp., Spokane, Washington, USA). The mean transect length (± standard error) was 64.7 ± 0.96 m.

Data collection began on 2 December 1992 and continued until 31 March 1993. By the end of the test period, snow geese had migrated from the study area. During the trial, no other damage management technique was employed at any treated or control field. Flags (white, $n = 2$, black, $n = 1$) and streamers ($n = 6$) were replaced during the course of the trial when all flagging or streamer material had ripped free from the lathe. At each visit to every field, the physical condition of flags and streamers was recorded.

All fields were visited at 7-day intervals throughout the test. During each visit, observers walked the four transects and collected all goose droppings within 30 cm of the midline of the transect. In addition, at the centre of each transect, observers collected a vegetation sample so that biomass could be estimated. To accomplish this, the observer tossed a 0.25 m^2 sampling frame over his shoulder and, using a pair of scissors, collected all of the above-ground vegetation within the frame. Sampling visits to each experimental and control field lasted ~40 min.

After collection, droppings and vegetation samples were immediately returned to the laboratory, placed in a drying oven at 37°C for 72 h, and then weighed.

Weights were taken as indicators of goose numbers and grazing damage, respectively (Bedard et al., 1986; Summers, 1990).

Analysis

We performed a two-way analysis of variance on ranks (Quade test; Conover, 1980) to determine whether the presence of geese at farms (as indicated by presence or absence of faeces) was different among treatments. The blocks consisted of the nine sampling dates (20 January to 31 March) beginning with the first date that droppings were detected in fields. We used a two-sided k-sample Smirnov test (Conover, 1980) to determine whether the snow goose pressure (as indexed by cumulative faeces per farm) differed across treatment types. Least squares regressions for vegetative mass versus time were calculated for the pre- and post-visitation periods for each of the treatment types. Heterogeneity and tests of equality of slopes were estimated using a covariance analysis (Snedecor and Cochran, 1980) to reveal trends in vegetative growth as a function of the presence (or absence) of geese.

Results

Snow geese remained on the salt marshes and salt hay meadows near our study sites until the end of January. At that time, geese were observed moving onto surrounding agricultural fields in large numbers. This movement was evident in our index of field use by snow geese.

The presence of geese on farms differed significantly as a function of treatment (Quade test, $t = 16$, $p < 0.01$). Geese appeared on control fields first, and continued to use these fields until their migratory departure. Next, geese were detected in fields with Mylar streamers. Finally, geese appeared in some (but not all) white- and black-flagged fields; this occurred 4–5 weeks following the first observation of geese in control fields (Figure 1).

Considering only those fields used by geese, we found that faeces mass differed among treatments (Smirnov test, $p < 0.025$). The total cumulative faeces per unit length of transect was greater for control fields than for fields with flags or Mylar streamers (Figure 2).

Although vegetative biomass appeared to differ among treatments, there was extreme variability within and among sites. No transformation was capable of eliminating this heterogeneity, and all slopes were statistically equal. Nevertheless, the data suggest that goose grazing negatively affected accumulation of vegetative biomass, i.e. there was a tendency for fields with geese to show a zero or non-positive slope, with the exception of fields with white flags (Figure 3). In this case, vegetative growth appeared unaffected by the presence of geese.

Discussion and management implications

Snow goose droppings were first collected in control fields on 20 January and dropping weights from these fields peaked on 3 March after a snowstorm. We
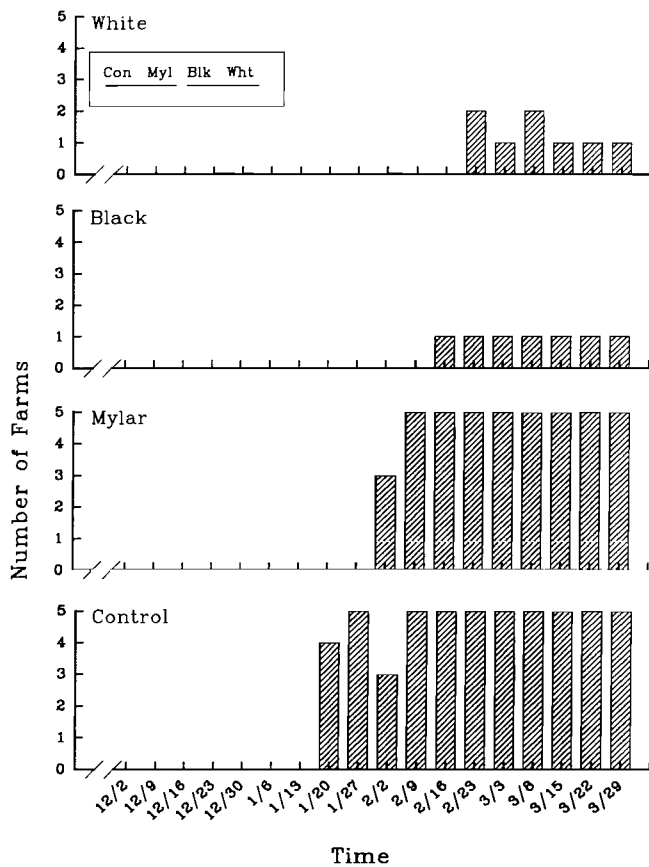
Figure 1. Number of farms (out of a possible five) where at least one of four transects contained snow goose faeces. The panel inset depicts similarity among treatments (underscore). Treatments were white plastic flagging, black plastic flagging, Mylar streamers, or bare (control) stakes. Horizontal (Time) axis gives the date of observation (month/day)
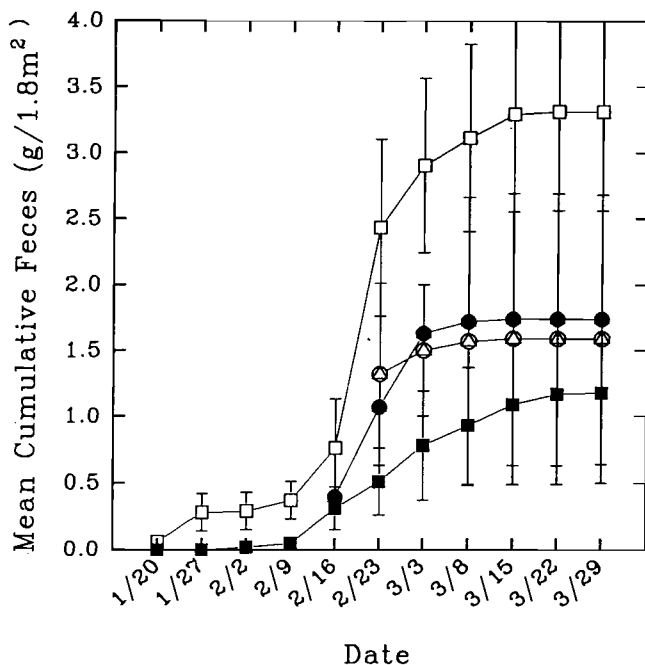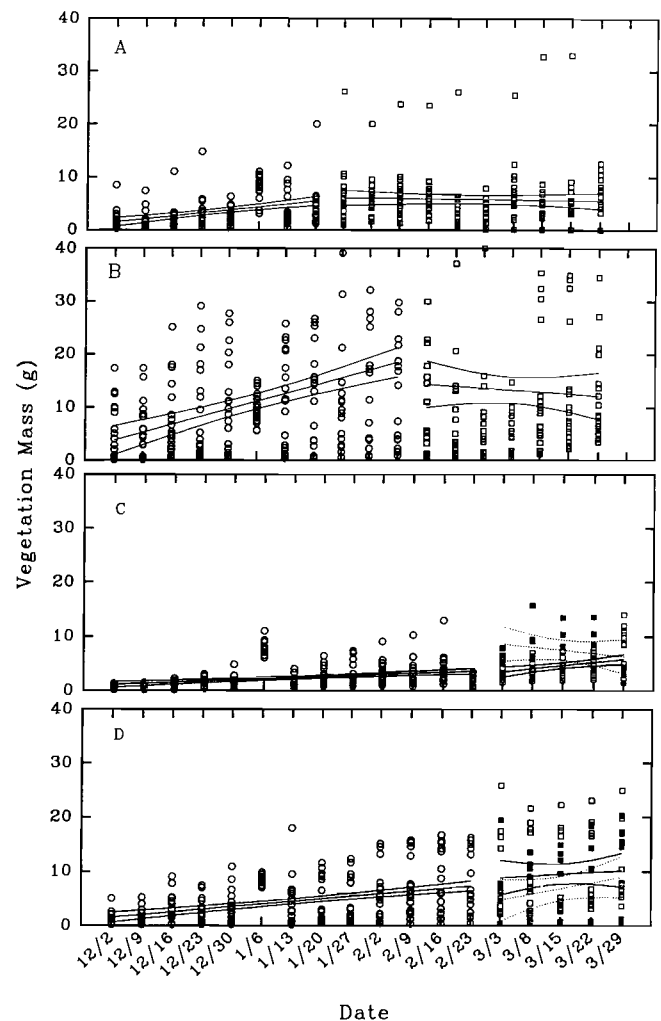

Figure 3. Vegetative biomass for all transects sampled across all farms as a function of sampling date for control (A), Mylar (B) black (C), and white (D) flagged fields. For panels A and B, open circles and the associated regression (and upper and lower 95% confidence limits) depict the relationship between mass of sampled vegetation per 0.25 m² and time for the period prior to the arrival of geese on fields. The open squares and regression depict the relationship between vegetation mass and time once geese had arrived at the farms. For panels C and D, open circles and the associated regression and confidence intervals (solid lines) depict the relationship between vegetation mass and sampling date for the period prior to the arrival of geese on fields. The solid squares and associated regression (dotted line) depict the vegetation–time relationship at those farms visited by geese. The open squares and associated regression (solid line) depict the vegetation–time relationship for those farms not visited by geese during the period when geese were visiting other farms in the area

Figure 2. Mean cumulative amount of faeces per unit length of transect as a function of sampling date. Treatments were white plastic flagging (△), black plastic flagging (●), Mylar streamers (■), or bare (control) stakes (□)

continued to collect droppings in control fields until the last measurement date of the experiment (31 March). For Mylar fields, droppings were first found on 2 February whereas in black- or white-flagged fields, droppings were first recorded on 16 and 23 February, respectively. Fewer of these fields were visited than either control fields or fields with Mylar streamers.

Not surprisingly, cumulative faeces mass reflected the presence of geese in fields. Mean cumulative mass for control fields was significantly greater than the mean masses recorded for flagged fields or fields with streamers.

Although there was no statistically significant evidence of grazing damage, the present experiment does demonstrate that white or black plastic flags can effectively deter snow geese from landing in fields. Mylar may also be effective for this purpose. These findings are consistent with reports concerning the repellency of white flags (Mason *et al.*, 1993) and Mylar streamers (Heinrich and Craven, 1990; Summers and Hillman, 1990). Because flags fashioned from garbage bags are considerably less expensive than Mylar streamers (~US$0.80 per unit versus US$1.20 per unit), we recommend the former over the latter. Further, we speculate that flagging may be even more effective when combined with other deterrent strategies, e.g. propane cannons, harassment (Knittle and Porter, 1988; Heinrich and Craven, 1990).

Flagging may be a useful snow goose damage control tool in locations other than agricultural fields, and particularly when other readily accessible feeding sites are available nearby. For example, flagging could disperse geese in marshes where excessive grazing has substantial negative impacts (Kerbes, Kotanen and Jefferies, 1990; Iacobelli and Jefferies, 1991; Hik, Jefferies and Sinclair, 1992). In a pilot test during the spring of 1993 (Dewey, 1993), results similar to those reported here for upland agricultural fields were obtained on a commercial salt hay meadow. We plan a more extensive evaluation of flagging in coastal marshes during the winter of 1993/94.

Acknowledgements

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